

METRA Instruments, Inc.

2257 E. MIDDLEFIELD ROAD, MOUNTAIN VIEW, CALIFORNIA 94040



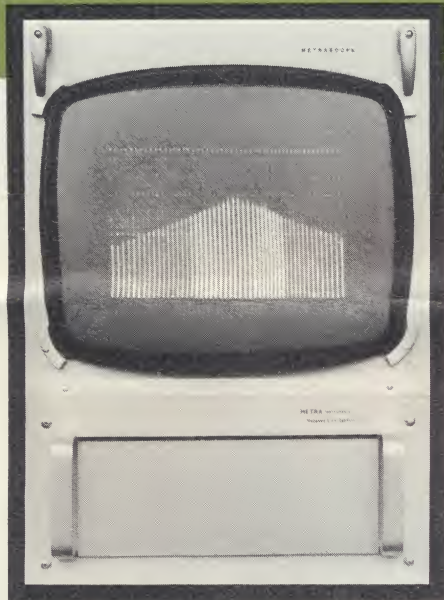
T. Nelson Sys. Cons.
Box 1546
Poughkeepsie, N.Y. 12603

PRINTED MATTER

METRASCOPE

A multi-channel, data monitoring instrument:

- TO DISPLAY 50 analog data channels in bargraph form;
- TO MEASURE each channel value in appropriate units such as °F, °C, PSI, etc.;
- TO ALARM when pre-selected levels are exceeded.



FEATURES

VARIATIONS IN CAPACITY
FROM 25 to 50 CHANNELS

QUICK-DISCONNECT,
MODULAR-CONSTRUCTION
CONTROL CIRCUITS

FRONT ACCESS
TO ALL COMPONENTS
WITHOUT REMOVAL
FROM CHASSIS

METRASCOPE scans the analog voltage of each data channel 30 times (or more) a second with a solid-state transistorized scanner. The signals are amplified and displayed in bar form on a 19" cathode ray tube in the same plane with an electronically generated grid, appropriately calibrated. The information is compared to a pre-selected high and/or low alarm level; signals exceeding the alarm levels activate a relay and are individually identified on the cathode ray tube by a pronounced brightening of the respective data bar. See photo.

Printed circuit, plug-in components make METRASCOPE completely flexible with respect to full-scale sensitivity, number of channels, calibration and type of grid. Suitable log, linear, or non-linear grid scales are available. Grid plug-in cards permit quick change of scale when desired.

Data may be recorded simply by photographing the display with a camera; no special attachments or lighting conditions are required. The electronically generated grid eliminates parallax and provides the appropriate grid lighting; camera location is not critical.

METRASCOPE

for information display in Power Plants, Petro-chemical Reactors, Wind-tunnels, Nuclear Reactors, Space Simulators, Environmental Test Labs, Engine Test Stands, Biological and Medical Research Labs, Hospitals, General Research Labs, and Universities.

METRASCOPE

to display process parameters such as temperature, pressure, position, stress, etc., or combinations of these.

METRA INSTRUMENTS, INCORPORATED
Mountain View, California

METRASCOPE

GENERAL SPECIFICATIONS

DISPLAY TUBE. . . 19" implosion-protected cathode ray tube with an aluminized P4 screen treated for anti-reflection (UL approved).

DISPLAY. . .

Sensitivity. . . Vertical Sensitivity as specified within following ranges: 0-10 mV minimum; 0-10V maximum.

Accuracy. . . 1% of full scale or .1mV, whichever is greater.

Grid. . . A linear electronically superimposed grid to eliminate parallax in readings is standard. Non-linear and log grids are available on special order.

DATA CHANNELS. . . Basic unit 25 channels; available to maximum of 50 in increments of 5 channels. Basic unit: every fifth channel brightened for rapid channel identification; other intervals available.

CALIBRATION SIGNAL. . . Appears as a row of dots across screen. Level adjusted by front panel control with digital readout; accuracy within 0.5% of full scale.

THERMOCOUPLE REFERENCE. . . Standard for thermocouple inputs.



ALARM. . . Alarm level appears as a row of dots across screen; accuracy 1% of full scale or 0.1mV, whichever is greater. All channels in alarm condition are brightened for rapid identification.

ELECTRICAL SPECIFICATIONS. . .

Input Impedance. . . 1 megohm

Common Mode Rejection Ratio. . . 25,000 to 1, minimum.

Scanning Rate. . . 30 Hz, minimum

Power Required. . . 108-125 volts AC, 50/60Hz; 150 watts (approximate maximum demand).

JUNCTION BOX. . . Accommodates 50 circuits (single or double ended).

MOUNTING DIMENSIONS. . .

Display Unit - 19" W x 17-1/2" H x 14" deep
Data Processing Unit - 19" W x 8-3/4" H x 22" deep.

Approximate shipping weight - 130 pounds

ORDERING INFORMATION

1. Number of channels
2. Type of Input
3. Level of input signal maximum
4. Define grid type and calibration
Note: If non-linear scale is specified, please give sufficient detail to completely define grid and scale values.
5. Alarm desired (high only, low only, both)

REPRESENTED BY

METRA INSTRUMENTS, INCORPORATED

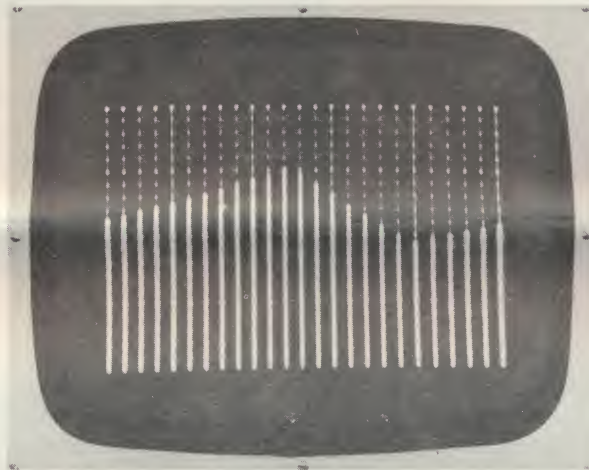
2257 East Middlefield Road • Mountain View, California 94040 • (415) 961-7249

METRA INSTRUMENTS, INCORPORATED

2257 East Middlefield Road
Mountain View, California 94040 • (415) 961-7249

METRANOTE #1

SO WHAT'S A METRASCOPE



First - Why is a METRASCOPE

The METRASCOPE has grown out of the need to simplify the assimilation of information and to make quick decisions. Formerly, industrial data collection systems consisted of an operator reading a number of isolated instruments. In many cases, the limit was reached where an operator was no longer able to read the data, make proper decisions and take proper corrective action within the limited time allowed with present high speed processes.

The METRASCOPE, a bargraph display of process or test parameters, solves the data collection problem in one glance and even, by preset alarm levels, helps with the decision making or corrective action. Operators, relieved of the data collection problem, can then devote their full attention to improving yields.

Now - What is a METRASCOPE

The METRASCOPE consists of four major components:

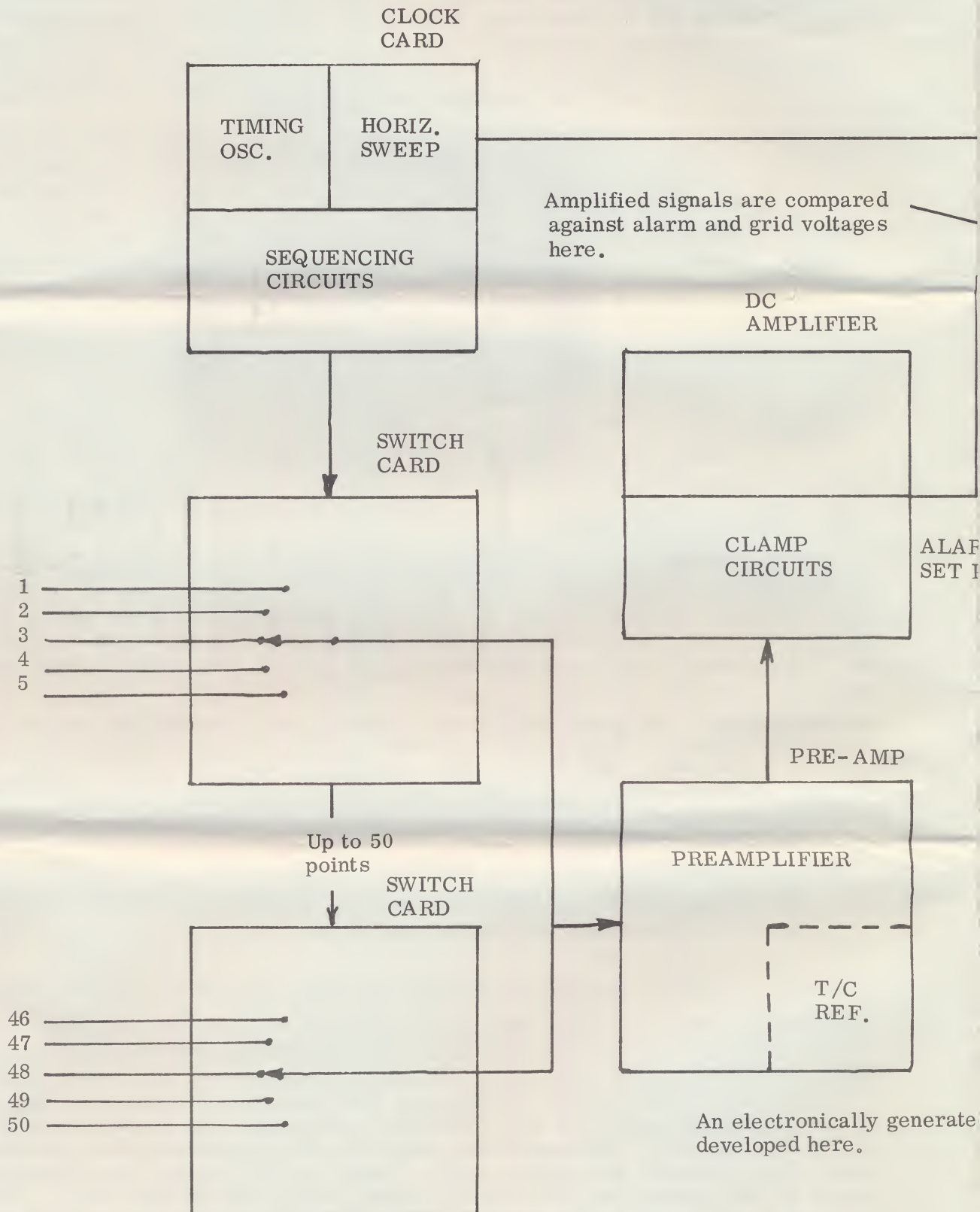
1. A High-speed Semiconductor Sampling Switch
2. An Ultra-stable Calibrated Amplifier
3. A Display Unit
4. A Control Unit

In operation, the high-speed switch sequentially samples the electrical analog signals generated by conventional transducers, such as thermocouples or strain gages. This sampling, which is at the approximate rate of 1500 samples per second, is essentially uninterrupted monitoring. The sampled information is then amplified by the calibrated amplifier and presented in bargraph form on the cathode ray tube of the display unit. The amplified signal is also presented to control circuits where it is analyzed for signal level. Signal levels outside the prescribed limits result in the generation of a control signal within the control unit. These signals may then be utilized by the processor for control and correction of the appropriate process variables. See the center pages of this brochure for a more graphical description.

Transducer inputs
go in here -

They are sampled sequentially
by solid state switches here -

They are accurately
amplified here -
(linear, logarithmic or
other non-linear)



and presented on the cathode ray tube here -

The cathode ray tube generates a spot of light

This sweep voltage steps the spot horizontally after each input transducer is sampled and then repeats for the next sampling sequence.



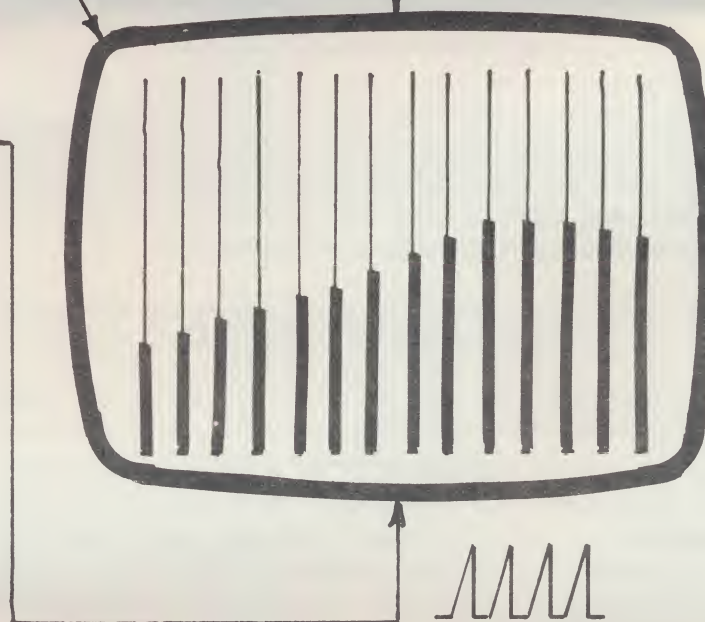
ALARM CARD

COMPARISON CIRCUITS

This output turns the spot of light on or off at the proper time to develop the display.

ALARM CIRCUITS

VERT. SWEEP



GRID CARD

This sweep voltage moves the spot of light vertically once for each transducer sampled.



METRA Instruments, Inc.

SCALE:

APPROVED BY:

DRAWN BY R.P.

DATE: 1/2/68

F. Fitting

REVISED

BLOCK DIAGRAM - METRASCOPE

DRAWING NUMBER
M/N 1

So - How is it Built

A modular construction principle developed for computer technology; card file construction, using printed circuit cards, is used in the design of the METRASCOPE. Briefly, rectangular cards, containing all of the appropriate components and etched for conductive paths, in place of wire, are constructed to perform electronic functions such as switching, signal amplification, signal comparison, etc.

The card file principle permits flexibility of design, simplified custom modification of the product and ultra simple "on line" maintenance. For example, to modify a standard METRASCOPE to meet a customer's specific requirement, the card or cards involved are replaced by appropriately modified cards. In some cases, the wiring at the back of the card file might also require alteration. In other cases, some cards might be eliminated or additional cards added.

Maintenance - Heaven Forbid

Maintenance of METRASCOPE, for the most part, will require the replacement of faulty circuit cards. Simple tests and procedures are set forth in the Maintenance Manual to guide the semi-skilled process technician in finding the faulty card. The faulty card may then be forwarded to Metra Instruments for repair. Hence, the processor need not employ skilled electronic technicians for maintenance and repair of the METRASCOPE. This one factor will be of great importance to the small processor who normally does not employ electronic technicians.

Equipment "down time" is virtually eliminated by the card file construction, provided the users maintain a supply of replacement cards.

Well - Where do you use it

Wherever there is analog information to display; in power plants, wind-tunnels, petro-chemical reactors, environmental test laboratories, nuclear reactors, engine test stand, hospitals, laboratories, you can use a METRASCOPE. You can use it anywhere there is a need for instant visual reference to fast-changing measurement parameters. Calibration is direct in units to suit your needs; in degrees Celsius or Fahrenheit (when thermocouples are used a thermocouple reference oven is provided) in decibels (a logarithmic amplifier is used to convert to db), pounds per square inch or any of the usual engineering units. The flexibility of the METRASCOPE (even arbitrary non-linear scales can be provided) makes it a useful instrument anywhere analog DC signals need to be displayed.

To Sum It Up

The METRASCOPE provides a superior means of assimilating a mass of data. It can be used with any transducer that puts out a DC signal in the range of 10 millivolts to 5 volts. The transducer outputs, displayed in bargraph form on a cathode ray tube, are calibrated in engineering units against an electronically generated grid. Adjustable alarm functions are provided and shown on the same display. Its use is universal - wherever electrical transducers are used.

METRA INSTRUMENTS, INCORPORATED

2257 East Middlefield Road
Mountain View, California 94040 • (415) 961-7249

METRANOTE # 2

THE METRASCOPE AS A STRAIN GAUGE DISPLAY SYSTEM

Introduction

The use of the strain gauge has grown widely in recent years because of its great versatility. Besides its fundamental use as a strain measuring device, the strain gauge can be adapted to measure leads, torques, pressures, vibrations and numerous other physical variables. With the METRASCOPE to permit simultaneous viewing of many parameters, the strain gauge and the METRASCOPE become a powerful tool for measurement and control. This METRANOTE describes the strain gauge, the METRASCOPE, and the characteristics of the two together.

The Strain Gauge

A resistance strain gauge is a transducer applied to a surface to measure its elongation or strain from an applied force. The strain gauge, wire or metal foil, depends on the fact that when a wire is stretched elastically, its resistivity is increased, partially due to the change in wire dimension and partially due to a change in resistivity. The ratio of the per unit change of resistance, $\frac{\Delta R}{R}$, to the per unit change in length, $\frac{\Delta L}{L}$, is the form factor, F , or,

$$F = \frac{\Delta R/R}{\Delta L/L}$$

The ratio $\frac{\Delta L}{L}$ is the per unit strain to which the object under test is being subjected. Thus knowing the form factor and the per unit resistance change the per unit strain is known, or

$$\frac{\Delta L}{L} = \frac{\Delta R/R}{F}$$

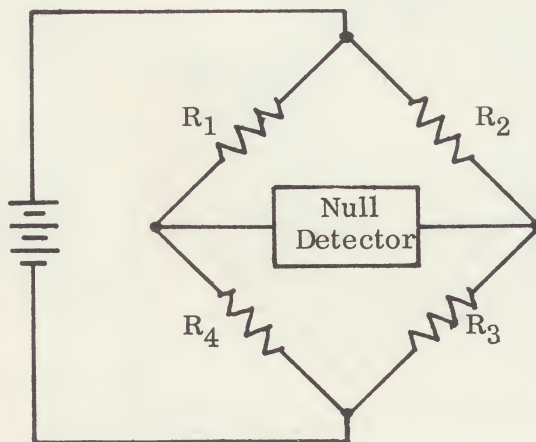
The Wheatstone Bridge

The strain gauge is generally used in one or more arms of a Wheatstone Bridge. A bridge circuit is a convenient and accurate method of measuring small resistance changes. Figure 1 shows a simplified version of a Wheatstone Bridge. When the resistances are adjusted so that no voltage appears across the detector, then the resistances are in the ratio

$$\frac{R_1}{R_4} = \frac{R_2}{R_3}$$

Figure 1

The Wheatstone Bridge



For convenience the strain gauge bridge is often used with all four resistance arms being nominally equal and with a high impedance detector, such as the METRASCOPE. The bridge is then initially balanced and becomes slightly unbalanced by the resistance change due to strain. For small unbalances and nominally equal arm resistance it can be shown that the output of the bridge is approximately linear and may be calculated from the expression:

$$E_o = \frac{E}{4} \cdot \frac{\Delta R}{R}$$

Since $\Delta R/R = \Delta L/L \cdot F$, the output voltage can also be written as $E_o = \Delta L/L \cdot F \cdot E/4$. This expression applies to a bridge with one active arm. The output for a bridge with more than one active arm is increased in proportion to the number of arms that are active. When the strain gauge bridge is used with small unbalances, the METRASCOPE is a "deflection instrument. With proper calibration, strain can then be read directly from the screen of the METRASCOPE.

The METRASCOPE

The METRASCOPE is a multi-channel, data-monitoring instrument which can display (and alarm) up to 50 channels of analog information in a calibrated bar graph format. The METRASCOPE scans the analog voltage of each channel at a rate of 30 (or more) times per second. The signals are amplified, compared against standard calibrated voltage levels, and displayed on a cathode ray tube screen in a bar graph form. An electronically generated grid gives them the appearance of being plotted on "graph paper." The data may be recorded simply by photographing the display with an ordinary camera--without parallax problems.

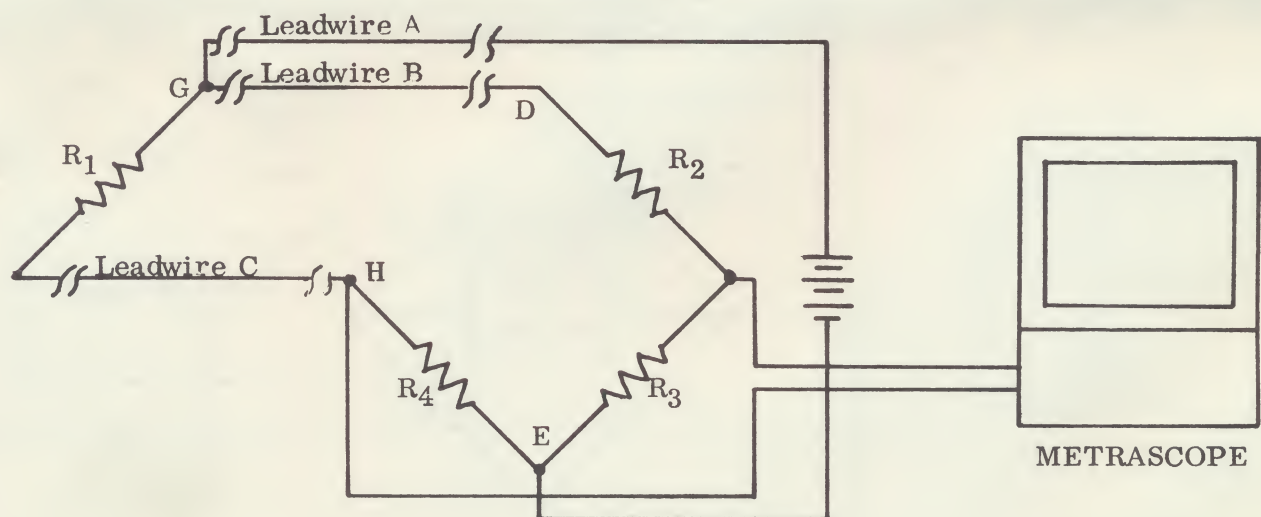
Some specifications of the METRASCOPE particularly pertinent to its use with strain gauges are:

Input Impedance	1 Megohm
Common Mode Rejection Ratio . .	25,000 : 1
Sensitivity	0 to 10 mV full scale or greater
Accuracy	1% of full scale

Another feature of the METRASCOPE helpful in strain gauge is an interval calibration voltage accurate to 1/2 of 1%, which appears as a row of dots across the screen. This voltage is adjustable by a digital-indicating multi-turn potentiometer.

An alarm function is also available, indicated when desired, by a row of dots across the screen, which gives a relay contact closure when any input signal exceeds the preset alarm level. The data point in alarm is indicated by increased brightness of the appropriate databar.

Figure 2
Compensation for Leadwire



The METRASCOPE - Strain Gauge Combination

Certain precautions are necessary in mating the strain gauge to any instrument used for measurement (including the METRASCOPE). Particular attention must be paid when long lines exist. Problems involve the temperature effect, shielding and common mode interference.

The temperature problem is best solved by using a dummy (unstressed) gauge subject to the same temperature effect as the stressed gauge. This usually involves mounting the dummy gauge on a similar surface to the stressed bridge so that it will also measure the effect of the dimensional change of the surface. The dummy gauge is mounted in the bridge in a position where its temperature effect will cancel the temperature effect in the stressed gauge.

In some installations it may be impossible to use a dummy gauge, and therefore a self-compensating strain gauge must be used. This introduces a new problem, however: that the effect of temperature on the gauge lead wires may be considerable. For example, a 100-foot run of 20-gauge copper wire--experiencing a temperature change of 10°F . can cause an error in a 120-ohm bridge circuit in the order of 350 microinches per inch. This effect can be eliminated by the circuit of Figure 2. In Figure 2, R_1 is the active arm of the four-arm Wheatstone Bridge. With the power supply connected to Points G & E, through power lead wire A, the resistance changes in lead wires B and C are equal, and the effects of lead wire resistance changes due to temperature are cancelled. The connection of the power supply to Point D would appear to be a logical one, since it would eliminate one of the long-lead wires; however, the change in resistance in lead wire C would unbalance the bridge. This method of connection can be successfully used for short runs in thermally stable environments. Temperature effects in lead wire A do not affect the balance of the bridge (i.e.: $\frac{R_1}{R_4} = \frac{R_2}{R_3}$); and the change of resistance in lead wire A has a negligible effect

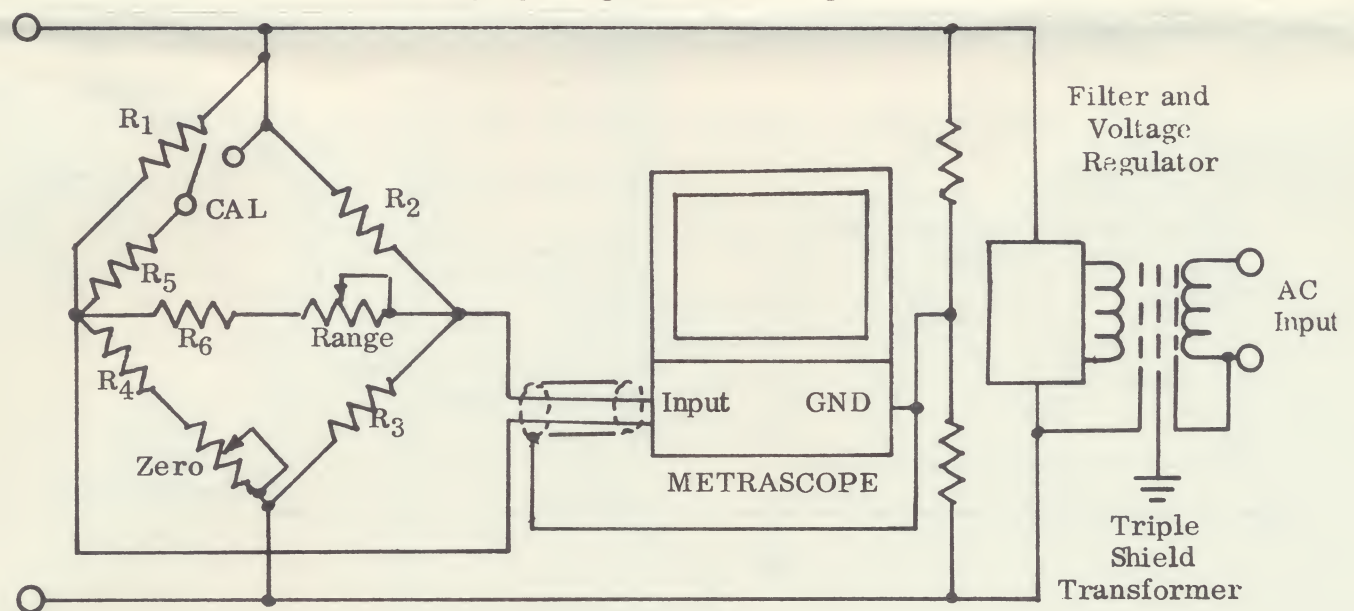
on the voltage (E), exciting the Wheatstone Bridge.

Gauge Excitation

If a single-ended amplifier (one which has its input signal referred to ground) were used, it would be necessary to have a separate power supply for each bridge. The METRASCOPE does not require individual power supplies since it uses a double-ended (differential) amplifier which can accept floating inputs and can respond essentially to only the difference signal between the two input lines. The differential amplifier also rejects interference signals that are common to both input lines.

Figure 3

Floating Input Signals with a Wagner Ground



The power supply transformer will inject an unwanted signal into the strain gauge circuitry which is a function of the interwinding capacity and lead length. Where leads are long and accuracy requirements are high, it is recommended that a triply-shielded power transformer be used to isolate the excitation supply from the power line. Transformers with primary to secondary capacitances of a fraction of a picofarad are available.

Shielding and Grounding

The primary consideration in applying shielding is that only one connection of a shield to ground should be made. Two connections add a ground loop and will in general cause a voltage gradient to exist along the shield.

If the transducer is floating, a single shield should surround the transducers and power supply and be returned to one side of the power supply (and not grounded elsewhere). See Figure 3). The common junction of the two equal resistors of relatively low resistance in series across the power supply (a "Wagner Ground") is then connected to the ground return to the METRASCOPE.

If the strain gauge is grounded, then the transducer shield is brought to the transducer ground and not to the instrument. (See Figure 4). In all cases the shield is returned to ground at only one place. If one side of the power supply is grounded, then the METRASCOPE must reject 1/2 of the total bridge power supply potential. It is recommended that a bridge power supply of not more than 15 volts be used in this case.

Calibration Circuit, Range & Zero Adjustments

Figures 3 and 4 show one fixed resistor and a switch in parallel with the active arm and adjustable resistors in the null circuit and in the R_4 circuit. This depicts a method of obtaining a calibration signal, range adjustment and zero adjustment.

Conclusion

As described above, the METRASCOPE permits a superior means of assimilating a mass of strain gauge data. Comparisons can be made and trends can be observed, both in space by simultaneous observation and in time by observing changes. Finally, simple recording can be made by photographic means.

Figure 4
Grounded Strain Gauge - Floating Input Signals

